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12 **EUROPEAN PATENT APPLICATION**

21 Application number: **90102436.4**
 22 Date of filing: **07.02.90**

51 Int. Cl.⁵: **F16K 1/22, F02C 9/20,**
F23L 13/08

30 Priority: **13.02.89 US 309257**
 43 Date of publication of application:
22.08.90 Bulletin 90/34
 64 Designated Contracting States:
AT BE CH DE DK ES FR GB IT LI NL SE
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54 Louver dampers for use in gas turbines exhaust systems and having blades protected against becoming warped.

57 Louver dampers for use in the exhaust systems of gas turbines have flat blades (17) each of which is provided with a lengthwise reinforcement (36) spaced from the major portion of its face which is upstream when the damper is closed and has sides welded thereto adjacent the side margins thereof. Each side of each reinforcement (36) has ports (40) which ensure contact of hot gases with the portions of the blade underlying the reinforcement so that the entire surfaces of each blade and its reinforcement are uniformly heated preventing blade distortion that would prevent the operation of the damper and destroy the effectiveness of seals (25) in case the damper is equipped therewith.

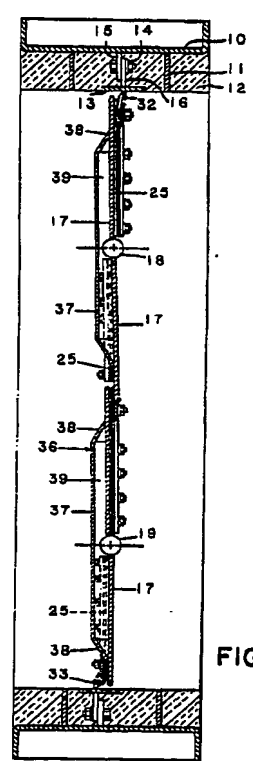


FIG. 3

EP 0 383 185 A1

LOUVER DAMPERS FOR USE IN GAS TURBINES EXHAUST SYSTEMS AND HAVING BLADES PROTECTED AGAINST BECOMING WARPED

Technical Field to Which the Invention Relates

The invention relates to exhaust systems for gas turbines. When a gas turbine is started, the volume, temperature and velocity of its exhaust gases very quickly reach their maximums. The exhaust systems of gas turbines are adapted to utilize heat which would otherwise be wasted to operate cogenerating systems such as heat recovery steam boilers. Such systems typically have a bypass into which the hot gas stream is diverted when, for one example, the cogenerating system is to be placed temporarily out of service. Louver dampers or hinged blade diverters are typically employed for this purpose.

Background Art

One example of a hinged diverter blade operable to shift the flow from either system to the other is disclosed in U.S. Patent 4,821,507, issued April 19, 1989. Alternatively, one or more louver dampers or a combination of louver and guillotine dampers may be positioned in the bypass and one or more louver dampers or a combination of louver and guillotine dampers may be incorporated in the exhaust system between the bypass and the steam boiler.

Because of the sudden build-up of the temperature in gas turbine exhaust systems, it is necessary for diverter blades or louver dampers to be able to accommodate thermal expansion forces. In U.S. Patent 4,821,507, a diverter blade is disclosed having that capacity and in U.S. Patent 4,823,836, issued April 25, 1989, leaf spring seals are provided which are constructed and arranged in a manner accommodative of thermal expansion forces in conjunction with both diverter blades and louver dampers.

In the manufacture of louver dampers, the weight of the louver blades is minimized by utilizing relatively thin metal stock and by providing a suitably reinforced and ported blade to enable interior surfaces, and surfaces upstream when the damper is closed, to be heated evenly in order to avoid blade distortions with temperature change.

Summary of the Invention

In accordance with the invention there is provided a louver damper for incorporation in the exhaust system of a gas turbine, the damper comprising framework 10,13 defining a rectangular flow path opening there-through, flat rectangular blades 17 and rotatable blade actuating means 18,19,22,23,24 mounted in the framework for rotating the blades between positions opening the flow path and positions closing the flow path, the blades 17 having a working clearance with respect to the framework 13 and to each other, characterized by a reinforcement 36 for each blade 17 on the face thereof which is upstream in the closed position of the blades, each reinforcement 36 including a rectangular central portion 37 spaced from the face and side portions 38 connected to the face adjacent the margins thereof, each of the side portions 38 having a plurality of holes 40 spaced lengthwise thereof with the series of holes of one side portion 38 offset with respect to the series of holes 40 of the other side portion 38, whereby hot exhaust gases circulate through the reinforcement 36 with turbulence such that the entire upstream face is simultaneously and uniformly so heated as to avoid blade distortion.

One form of the louver damper of the invention is further characterized in that the blade actuating means comprises two shafts 18,19 for each blade 17, each shaft having first and second ends, the first ends being welded to the opposite ends of the blades 17 in alignment with the lengthwise centerline thereof, the blades 17 being within the flow path one above the other, the second shaft ends being rotatably supported by the framework with the axes of the blades parallel and in the same vertical plane, and still further characterized in that the first ends of the shafts 18,19 of each blade 17 are welded thereto close to the ends thereof and each reinforcement 36 includes end gussets 39 normal to the said face and welded thereto and to the first shaft end.

The invention is further characterized in that the framework 10,13 may include a supporting frame 10, an inner frame 13, insulation 12 between the frames, a connection 14,14A,15,16 between the frames and within the insulation, the connection being of a type enabling expansion forces to be accommodated, the inner frame 13 being provided with seal seats 32,33 extending about and into the flow path with working clearances with respect to the blades 17, seals 25 extending about the margin of the blades 17 for engagement with said seats 32,33, one of the margins of the blades which are proximate when the blades are in their closed

position being provided with a lengthwise seal 25 for engagement with the other of the last named margins, the seals being of a type enabling expansion forces to be accommodated without blade distortion.

Still further objects, features and advantages of the invention will become apparent from the following detailed description of a presently preferred embodiment of the same taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

In the accompanying drawings, which illustrate a preferred embodiment of a louver damper in accordance with the invention,

Fig. 1 is an elevation of the upstream side of the damper with the louver blades in their closed or operative position;

Fig. 2 is a view of the right hand end of the same as seen in Fig. 1;

Fig. 3 is a section on an increased scale taken approximately on line 3 - 3 of Fig. 1;

Fig. 4 is a fragmentary section, on a further increased scale, taken approximately on line 4 - 4 of Fig. 1;

Fig. 5 is a fragmentary cross-sectional view illustrating the leaf spring seals located at a corner of one of the louver blades; and

Fig. 6 is a fragmentary view of a portion of one louver blade with parts broken away illustrating the leaf spring seal arrangement.

Detailed Description of Preferred Embodiment

The louver damper illustrated by the drawings includes a frame, generally indicated at 10 (Fig. 1) which, like the adjacent duct sections, is rectangular and formed of appropriate lengths of outwardly opening channel stock, having on its inner surfaces anchors 11, (Fig. 3), for castable refractory 12 rendering the frame 10 a cold frame. The frame 10 differs from those of the adjacent duct sections in that its top, bottom and side walls (Fig. 4) have corresponding walls of an inner frame 13 joined thereto through the refractory 12 by a series of nut and bolt connections 14, 14A. These nuts and bolts interconnect a series of mounts 15 fixed on the inner surfaces of the cold frame 10 with supports 16 on the proximate surfaces of the inner frame 13. The holes for the bolts 14A in the supports 16 are oversized to enable thermal expansion forces to be accommodated.

The louver damper has two flat, rectangular

blades 17 of substantial length (Fig. 3). Each blade 17 has aligned shafts 18, 19 centrally of its ends which extend through sleeves 20 (Fig. 1) in the refractory 12. The sleeves are welded to the frames 10, 13. The shafts 18, 19, and the two blades 17, when closed, lie in essentially the same vertical plane, the shafts being supported by bearing assemblies 21 on the outside of the frame 10 which also seal the sleeves 20. The shafts 18 are stub shafts while the shafts 19 have arms 23 interconnected by a link 22 (Fig. 2). One of the shafts 19 is coupled to an actuator 24 which may be of any type operable through arm 23 and links 22 to turn the two blades 17 in unison and to the same extent between closed (operative) and open (inoperative) positions.

The blades 17 are so dimensioned that when mounted in the frame 13, there is a working clearance between the parts and their opposite side edges with respect to the corresponding walls of the frame 13. The blades 17 are also so dimensioned that, when in their operative position in which they lie substantially in the previously referred to plane, there is a working clearance between their proximate side edges.

In order to prevent hot gas from flowing through the working clearances, leaf spring seal assemblies, generally indicated at 25 (Fig. 4), are secured to the margins of the blades 17. The assemblies are shown as in accordance with U.S. Patent 4,823,836, issued April 25, 1989.

In Fig. 5 the assemblies 25 are shown as connected to one of the proximate side edges of the blades 17 and in sealing engagement with the proximate side edges of the other. The side edge of the blade provided with the leaf spring seal assembly has a lengthwise series of studs extending through oversized holes 26A in one end of each of the leaf springs 27, 28, 29 and through an oversized hole in the clamping bar 30. Nuts 31 threaded on the studs 26 lock the assembly in place. The leaf springs 28, 29 are progressively narrower than the leaf spring 27 (Figs. 5 and 6). The other or free ends of the leaf springs are bent to the same extent along a common line and are held tensioned by the free end of the clamping bar 30 which is inclined in the same direction but to a lesser extent than the leaf springs. While the oversized holes 26A through which the studs 26 extend enable thermal expansion forces to be accommodated, in practice, the sealing means at the blade margins is effected (Fig. 6) by a lengthwise series of assemblies 25. These assemblies are positioned with a gap between the clamping bars of two assemblies and with expansion gaps between corresponding leaf springs of the assemblies. The leaf springs so disposed and arranged that gas flow through the gap between any two corresponding

leaf springs is blocked by at least one other leaf spring.

In order for the leaf spring seals to be effective when the blades are in their closed or operative positions, the inner surfaces of the frame 13 are provided with seats 32,33. The U-shaped seat 32 extends along the top side of the frame 13 downwardly along the sides thereof with a working clearance between their ends and the shafts 18 of the upper blade 17. A like seat 33 extends along the bottom side of the frame 13 with a working clearance between its ends and the shaft 19 of the lower blade 17. The seats 32,33 are identical except that they are on opposite sides of the vertical plane inclusive of the axes of the shafts 18,19. In the embodiment of the invention illustrated by the drawings, the blades 17 turn from their closed positions, as seen in Fig. 3, in a counterclockwise direction to their open position.

For proper sealing to occur, the seats 32,33 are offset from the common plane (Fig. 3). Leaf spring seal assemblies 25 extend along the margins of the blades 17 for engagement with the appropriate one of the seats 32,33 and to permit the blades to turn between their open and closed positions.

The frame 13 is also provided with seats 34,35 (Fig. 1) for leaf spring seal assemblies 25 mounted on the proximate end margins of the blades 17. The seats 34,35 are located on opposite sides of the vertical plane inclusive of the shaft axes for engagement by the appropriate seal assembly when the blades are in their operative closed position.

Referring to Figs. 1 and 3, each blade 17 has a reinforcement 36 on its face which is upstream when the damper is closed. Each reinforcement 36 is shown as an assembly having a flat central section 37 and flat side sections 38. The latter sections are inclined towards and welded to the blade close to the opposite margins thereof so as to space the central section from the underlying blade area for the purpose hereinafter indicated. The reinforcing assembly is completed by end gussets 39.

Such an assembly, while necessary to avoid the use of thicker blades, nevertheless shields the major portion of its blade from the hot exhaust stream, thereby presenting a problem of uneven heating of the blades.

To prevent warpage when the blades are subjected to the sudden blast of hot gas when the turbine is started, each side section is provided with a series of holes 40 (Fig. 1) with the holes in one side section 38 offset with respect to those in the other side section. With this construction, the hot exhaust gas not only impinges against portions of each blade surrounding its reinforcement but

also flows through each reinforcement with turbulence. Thereby the heating of all surfaces of the reinforcement and underlying portions of the blades is ensured and undesirable blade distortion avoided.

As already indicated, any such distortion would render ineffective proper sealing of the clearance between the blades and correspondingly adversely affect the operation of the damper.

While there has herein been disclosed and described a presently preferred embodiment of the invention, it will nevertheless be understood that the same is by way of illustration and not by way of limitation and the scope of the invention is limited only by the proper interpretation of the appended claims.

Claims

1. A louver damper for incorporation in the exhaust system of a gas turbine, said damper comprising framework (10,13) defining a rectangular flow path opening therethrough, flat rectangular blades (17) and rotatable blade actuating means (18,19,22,23,24) mounted in said framework for rotating said blades between positions opening said flow path and positions closing said flow path, said blades (17) having a working clearance with respect to the framework (13) and to each other, characterized by a reinforcement (36) for each blade (17) on the face thereof which is upstream in the closed position of the blades, each reinforcement (36) including a rectangular central portion (37) spaced from said face and side portions (38) connected to said face adjacent the margins thereof, each of said side portions (38) having a plurality of holes (40) spaced lengthwise thereof with the series of holes of one side portion (38) offset with respect to the series of holes (40) on the other side portion (38) whereby hot exhaust gases circulate through the reinforcement (36) with turbulence such that the entire upstream face is simultaneously and uniformly so heated as to avoid blade distortion.

2. The louver damper of claim 1 further characterized in that said blade actuating means comprises two shafts (18,19) for each blade (17), each shaft having first and second ends, the first ends welded to the opposite ends of the blades (17) in alignment with the lengthwise centerline thereof, the blades (17) being within the flow path one above the other, the second shaft ends rotatably supported by the framework with the axes of the blades parallel and in the same vertical plane, and still further characterized in that the first ends of the shafts (18,19) of each blade (17) are welded thereto close to the ends thereof and each re-

inforcement (36) includes end gussets (39) normal to said face and welded thereto and to the first shaft ends.

3. The louver damper of claim 1 further characterized in that the framework (10,13) includes a supporting frame (10), an inner frame (13), insulation (12) between the frames, a connection (14,14A,15,16) between the frames and within the insulation, said connection being of a type enabling expansion forces to be accommodated, said inner frame (13) provided with seal seats (32,33) extending about and into the flow path with working clearances with respect to the blades (17), seals (25) extending about the margin of the blades (17) for engagement with said seats (32,33), one of the margins of the blades which are proximate when the blades are in their closed position being provided with a lengthwise seal (25) for engagement with the other of the last named margins, the seals being of a type enabling expansion forces to be accommodated without blade distortion.

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FIG. 2

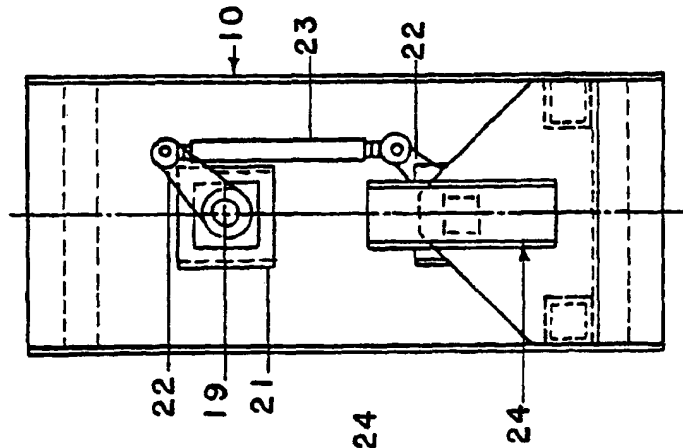
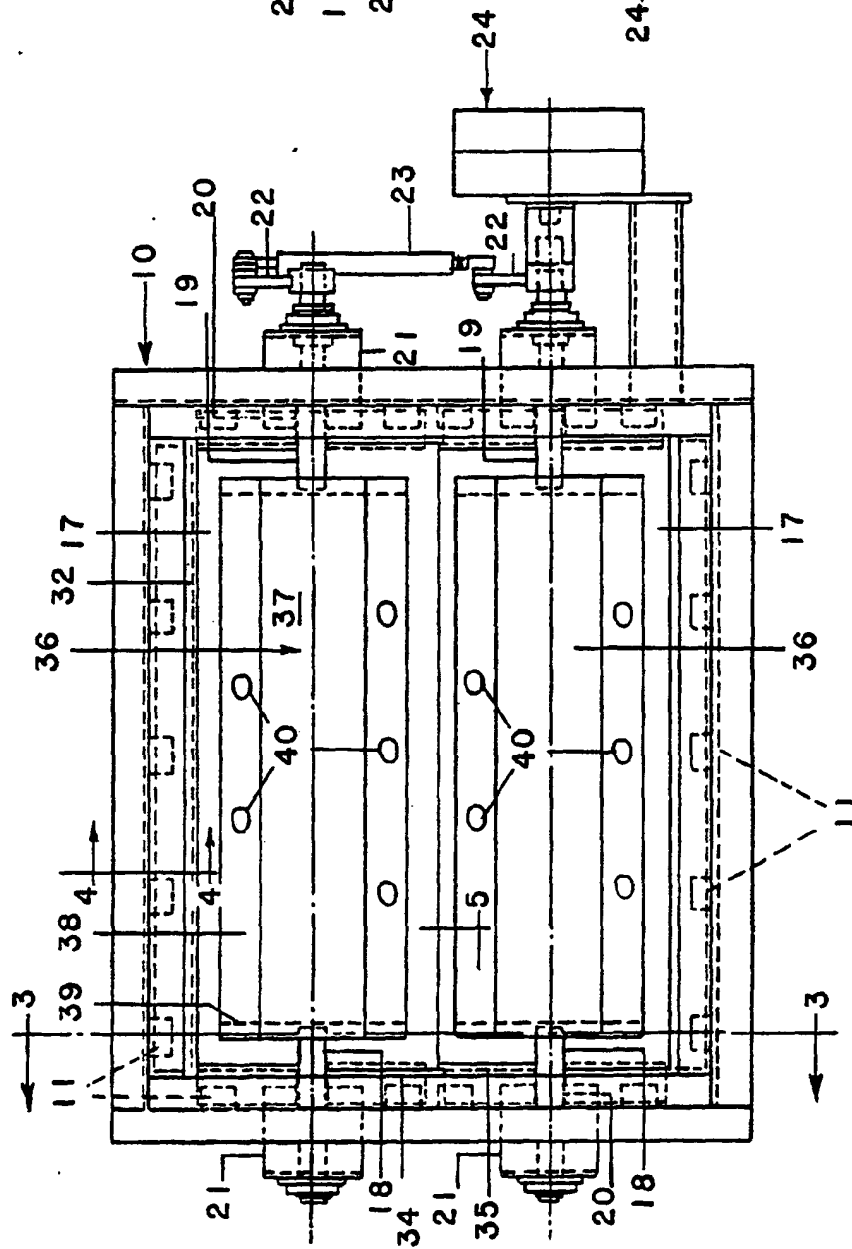


FIG. 1



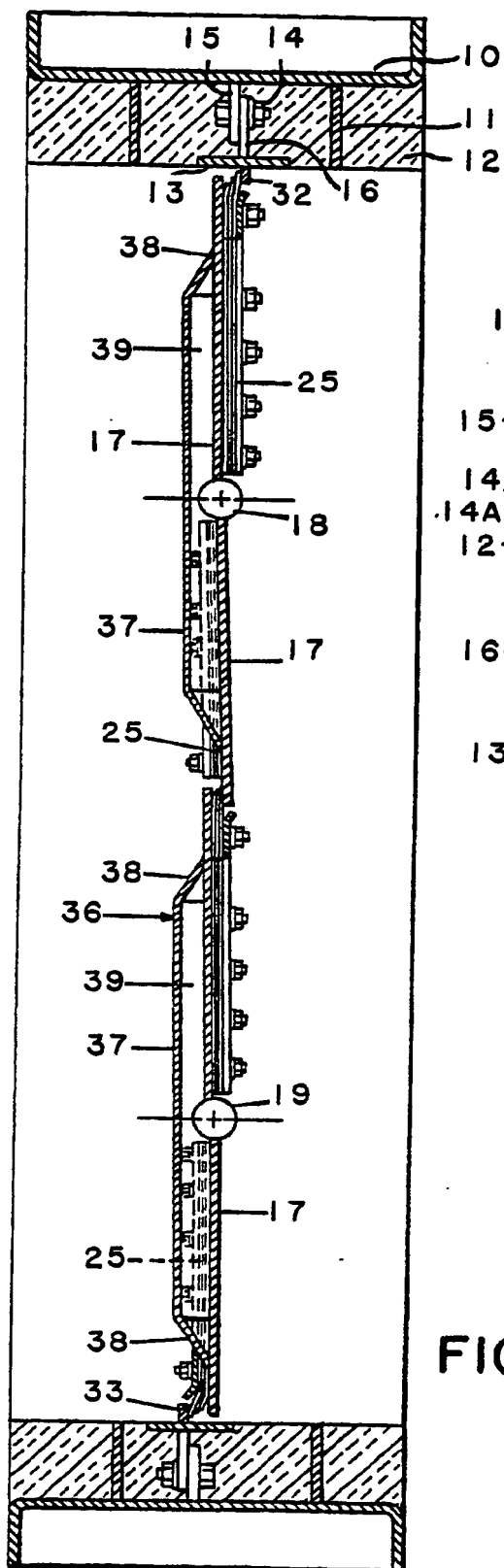


FIG. 3

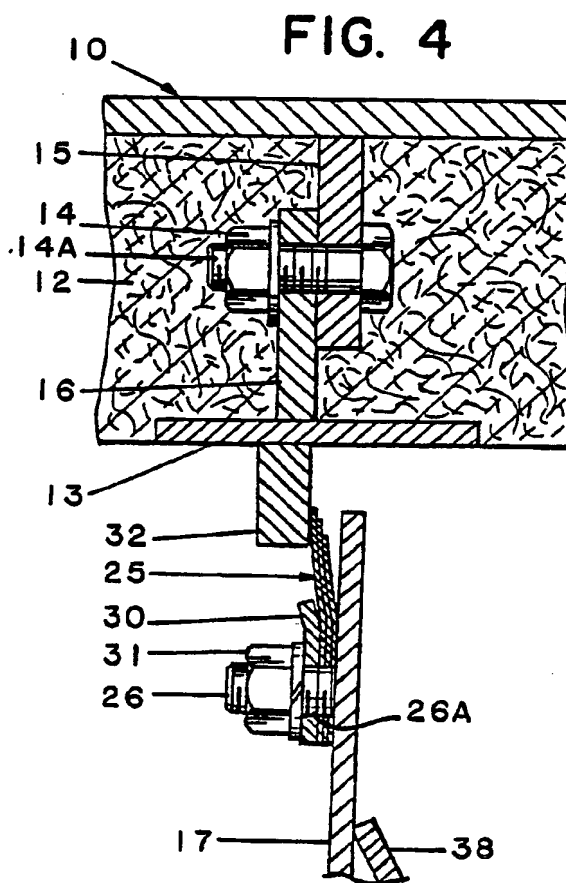


FIG. 4

FIG. 5

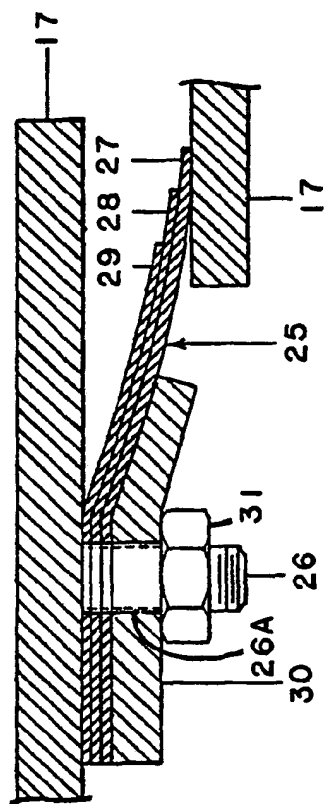
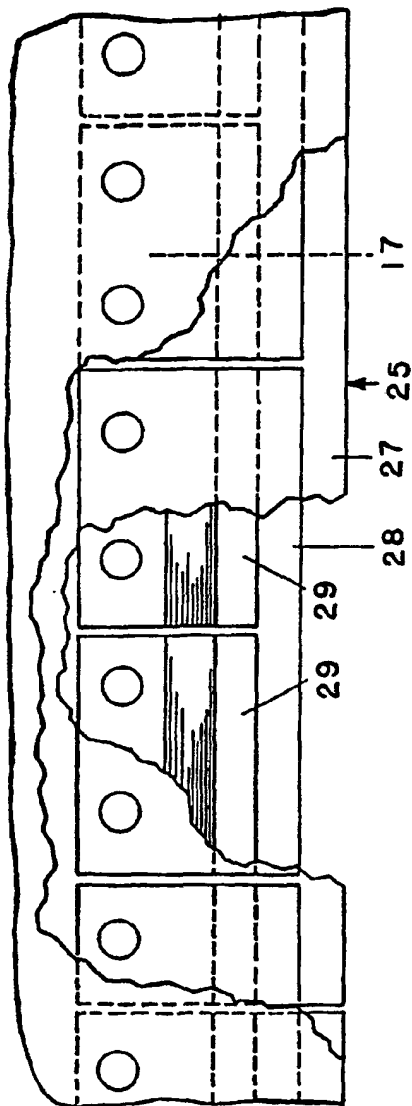


FIG. 6





European Patent
Office

EUROPEAN SEARCH REPORT

Application number

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | EP 90102436.4 |
|---|--|--|---|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.) |
| D, P, A | <u>US - A - 4 823 836</u> (BACHMANN et al.) * Belonging text; fig. 2-4, 6-10 * | 1, 3 | F 16 K 1/22 F 02 C 9/20 F 23 L 13/08 |
| D, A | <u>WO - A2 - 88/09 458</u> (BACHMANN INDUSTRIES INC.) * Belonging text; fig. 3-6 * | 1, 3 | |
| A | <u>US - A - 4 077 432</u> (HERR) * Totality * | 1, 3 | |
| A | <u>US - A - 3 698 429</u> (LOWE et al.) * Belonging text; fig. 1, 3-8, 13 * | 1, 3 | |
| A | <u>GB - A - 1 598 427</u> (FORSTER W. POWER PRODUCTS LTD.) * Totality * | 1, 3 | |
| | | | TECHNICAL FIELDS SEARCHED (Int. Cl.) |
| | | | F 16 K 1/00 F 16 K 11/00 F 02 C 7/00 F 02 C 9/00 F 23 L 13/00 F 24 F 13/00 |
| The present search report has been drawn up for all claims | | | |
| Place of search VIENNA | | Date of completion of the search 23-04-1990 | Examiner ROUSSARIAN |
| CATEGORY OF CITED DOCUMENTS | | | |
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